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A SOURCE OF LEAD CONTAMINATION OF CISTERN WATER.

REPORT OF AN EXAMINATION OF THE DRINKING WATER SUPPLY SYSTEM AT THE U. S. FISH HATCHERY STATION, TEN POUND ISLAND, GLOUCESTER, MASS., FOR POSSIBLE SOURCES OF LEAD CONTAMINATION.

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The investigation here reported was made in accordance with a request from the United States Employees' Compensation Commission to the Public Health Service.

The fish hatchery with which this report deals is located on an island (Ten Pound Island) in the bay of Gloucester, Mass. On this island, which is comparatively level and, hence, to outward appearances, presents little likelihood of a large amount of surface drainage, there are to be found the two main hatchery buildings and a number of other buildings, such as the pumping plant, shops, etc., necessary to the conduct of the establishment.

The two main fish-hatchery buildings are of frame construction, resting on brick foundations. One of these buildings is a single story; the other, which is of principal concern in this report, is two stories in height.

DRINKING WATER SUPPLY AT THE FISH HATCHERY.

The water used for drinking purposes at the station is rain water that falls on the unpainted roof of the two-story hatchery building. The water drains from the roof into copper gutters (unpainted on the inside), and then into two 3-inch copper drain pipes (also unpainted on the inside). Neither the copper gutters nor the drain pipes are soldered together. The two drain pipes empty into a cistern located beneath the floor of the building. This cistern, which is of about 4,500 gallons capacity, is made of brick and cemented on the inside.

There are three outlets for the water from this cistern. One is an overflow drain pipe and the other two are galvanized-iron pipes serving the sinks, one of which is on the ground floor of the building and directly over the corner of the cistern and the other on the second floor of the building in the kitchen. According to a statement made by the superintendent of the station, a short piece (about

6 to 7 feet) of soft pipe (sample was obtained) was used until July, 1920, to convey water from the cistern to the ground-floor sink. In July, 1920, this pipe was removed and the cistern was thoroughly cleaned. On the second visit of the writer, the cistern was again drained and thoroughly cleaned. The cistern was found to be in excellent condition and, with the exception of a thin layer of black organic sludge, was found to be perfectly clean.

POSSIBLE SOURCES OF LEAD CONTAMINATION.

From the examination of the drinking water system it appeared that there were only three possible sources of lead contamination; namely—

1. Lead pipe removed in 1920.
2. Lead paint which might possibly have gotten into gutters or drains.
3. Lead flashing on one side of the stair well opening, leading out on the roof, and on the lower side of two dormer windows, a total length of approximately 16 to 17 feet.

With these facts in mind, four samples of water (1, 2, 3, and 4) were obtained on the occasion of the first visit of the investigators, and also a sample of the old pipe which was removed in July, 1920. A small piece of flashing was also obtained. On a second visit to the island, two additional samples of water (5 and 6) were obtained, and also a large piece of the flashing.

METHOD OF ANALYSIS.

The samples of water were analyzed according to the procedure outlined in the report of the Committee on Standard Methods, of the American Public Health Association.

Result of analysis.

Sample No.	Source.	Amount of sample (c. c.).	Lead found (parts per million).
1	Cistern (top)	1,820	1.9
2	Ground floor pump	3,470	.4
3	Second floor pump	3,510	.6
4	Cistern (bottom)	1,740	6.4
5	Cistern (top)	3,800	.96
6	Cistern (bottom)	3,800	3.84

The analyses of this series of samples show that lead was present in all cases. The samples taken at the two pumps averaged 0.5 parts of lead per million, the top water of the cistern 1.43 p. p. m., and the bottom cistern water 5.12 p. p. m. It would appear from these results that a portion of the lead at least was in the form of insoluble lead compounds and was present in a state of suspension.

This has been found to be true in previous studies by other investigators.

The quantity of lead necessary in drinking water to produce the symptoms of poisoning is highly variable. Since lead is a cumulative poison, the quantity ingested would depend on the degree of contamination of the supply, the amount of water consumed daily, and the total number of days of consumption. The production of the symptoms of poisoning would, in practically all cases, vary, because of the high degree of variation of individuals in the susceptibility of the toxic action of lead.

Concerning the consumption of leaded water, Mason [1] says:

"* * * No water to be used for drinking purposes should contain lead compounds in quantity greater than what would correspond to half a part per million of metallic lead."

Doctor Summerville in a paper on "Water" [2] says:

"Lead to the extent of 0.25 parts per million is sufficient to condemn a potable water."

Weston [3] quotes the following cases reported by Prof. Reid Hunt, in which a considerable number of persons were poisoned by drinking water containing the following amounts of lead:

Amount of lead, p. p. m.:	Place.
0. 5–1. 6	At Sprokhoevel (in Westphalia), (Lemmer).
0. 7–12. 5	At a village in the Taunus (Schwenkenbecher and Neisser).
0. 998–9. 983	At Sheffield (White and Allen).
1. 997	At Huddersfield (Aird).
1. 143–11. 98	At Huddersfield (Stevenson).
1. 43–4. 28	At Manchester (Calvert).
2. 00–15. 00	At Castle Claremont (de Mussy).
8. 7	At Keighley (Stevenson).

"Amounts of lead, p. p. m., which a number of writers have stated to be poisonous or tolerated are as follows:

"0.36 may be poisonous (A. Smith).

"1.41 may not be poisonous (A. Smith).

"0.36 maximum permissible amount (Rubner).

"0.3 or, at most, 0.5 permissible (Schwenkenbecher & Neisser).

"0.7 maximum permissible amount (Steiner).

"0.71 tolerated (J. Smith).

"1.00 tolerated (Gartner) (Telekey).

"1.43 tolerated (?) (White)."

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[1] Examination of Water. By W. P. Mason. Wiley & Sons, N. Y., 1917.

[2] Quoted by Mason.

[3] Lead poisoning by water, and its prevention. By Robert Spurr Weston. Jour. N. E. Waterworks Assoc., vol. XXXIV, No. 4, December, 1920, p. 257.

From a review of the facts as brought out by this investigation, and the consideration of the past experience in this field, it is concluded that the presence of the amount of lead found in the water supply at the station may constitute a true health hazard.

CONCERNING THE SOURCE OF LEAD.

The analysis of the lead pipe removed in July, 1920, shows it to be largely composed of lead. If an average of the lead content of the top and bottom water of the cistern is taken, we find it to be 3.3 parts of lead per million of water; and assuming that the cistern of 4,500 gallons capacity had been emptied twice in the interval between July, 1920, and February, 1922, it would have been necessary for 112 grams of lead to remain in the cistern after its cleaning in July, 1920, to give the water this lead content. For this quantity of lead to have remained in the cistern after cleaning seems so unlikely that it is not believed that the old lead pipe removed in July, 1920, can be the source of the lead found in the cistern at the time of investigation.

It was noted that possibly some paint used in painting the outside of the gutters and drains might adventitiously have reached the inside of these appurtenances. This as a source of lead, however, is not to be considered seriously; for lead in paint is highly insoluble in water (its use in building paint would not be advisable if it were); in fact, it is so insoluble that it would take extremely large amounts of lead paint in such a case as this to constitute a hazard.

It seems reasonable, then, by this process of elimination, to return to the flashing, of which there are some 16.5 feet on the roof, and examine it as a possible source of lead in the system under consideration. A piece of the flashing was analyzed and found to be composed largely of lead. A large piece was removed on the occasion of the second visit to the station and later examined under the microscope by reflected light. This was found to be corroded. In several places that had been subjected to weathering it was found to be thinner than in other places where it was protected from such action, though it was impossible to measure the actual thickness with calipers because of the softness of the metal.

It seems highly possible for the flashing (subject, as it is, to the action of salt spray and every rainstorm) to have been the source of such an amount of lead as called for in the estimate made above.

Flashing, as the source of lead in cases such as the one under consideration is not a rarity, as is shown by the experience of the Bureau of Lighthouses. On page 165 of the Regulations of the United States Lighthouse Service for 1911, the following is found:

"To purify rain water contaminated with chloride of lead from salt spray resting in the leads of structures, put a small quantity of pulverized chalk or whiting into the cistern and stir well after each rain."

Here are regulations concerning cases analogous to the one here reported.

CONCLUSIONS.

It is the opinion of the writer, after carefully reviewing all of the foregoing facts, that the flashing on the roof of the hatchery buildings, from which rain water is collected and then used for drinking purposes, is the source of the lead found in the water under investigation.

RECOMMENDATIONS.

It is recommended that the Public Health Service advise against the use of lead in the construction of roofs, the drainage from which is to be used for drinking purposes.

EFFICIENCY OF VARIOUS KINDS OF VENTILATING DUCTS.

A Study of the Uniformity of Air Distribution Attained with Ventilating Ducts of Various Designs.

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INTRODUCTION.

The Second Report of the English Departmental Committee Appointed to Enquire into the Ventilation of Factories and Workshops (London, 1907) presented highly suggestive researches on the effect of the design of ventilating ducts upon the uniformity of air distribution. The studies of the committee demonstrated that it is difficult to secure good distribution with branch ducts constructed at right angles to the main duct, but that it is easy, by inclining the branch ducts at an angle of 30°, to attain a fairly uniform air flow at all points. Another point brought out by these English experiments—the influence of tapered as compared with untapered main ducts—appears to have attracted less general notice. In regard to exhaust ducts, the appendix to the second report of the departmental committee states that "the effect of substituting a tapered for a uniform parallel-sided main duct was always to exaggerate the difference in air flow through the different branch ducts or openings. For example, the currents through ducts A and D were as 1 to 1½ with the uniform air duct, but as 1 to 2 with the tapering air duct. A main exhaust air duct tapering toward the far end is thus not merely of no use in helping to equalize the flow through the branch air